DEHYDRATION OF ANIMAL WASTES FROM LIVESTOCK MARKETS

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Contents

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DEHYDRATION OF ANIMAL WASTES FROM LIVESTOCK MARKETS

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Summary

Dehydration of cattle manure from livestock markets is a practical method of reducing the moisture content to a low level. The dried material can be merchandised as a specialty fertilizer.

The four dehydrating plants covered in this study used rotary dryers with internal flighting. All dryers were direct fired using natural gas. The dehydrators had a relatively large electrical power demand.

The moisture content of the raw material coming into the plant ranged from 38 to 65 percent. Raw material above 60-percent moisture tends to form balls which are extremely difficult to dry. Other problems which must be considered in operating a dehydrating plant are the possibility of fire in the storage areas, the abrasive effects of the dried product on duct work and elevator and auger housings, the effects of dust caused by dried material upon both workers and equipment, and the odor which is generally present at a manure dehydrating plant.

The total operating cost for producing a pound of dried product ranges from 1.6 to 2.2 cents. Labor costs account for two-thirds of this total. Other costs include fuel, electricity, and repairs. Generally, the selling price of the dehydrated product only covers costs, and no profit is realized. Dehydration, however, may be the lowest-cost method of disposing of large volumes of cattle manure and bedding.

The dehydrated product is sold as a low-analysis fertilizer packaged in small units and is retailed through hardware stores, nurseries, and lawn and garden supply stores.

Background

The problem of how to dispose of animal wastes is not a new one. Research investigating the methods of disposal was being conducted during the late 1940's by the livestock market industry. Cattle receipts at the nine larger markets averaged 1,350,000 head for the year, 1947. This was an average daily capacity of approximately 3,700 head, which produced in excess of 100 tons of manure daily, exclusive of bedding. It was obvious that livestock markets needed to find a disposal method other than spreading wastes on the land.

In the early 1950's, some livestock markets began constructing dehydration plants. Dehydration, as defined by Henderson and Perry[1], is the removal of moisture to a low moisture content, nearly bone-dry condition. Bone-dry material has all the moisture removed.

Owners of dehydration plants were confronted with many problems — some operational, others involve the design of the system. In an attempt

[1] Henderson, S. M., and Perry, R. L. Agricultural Process Engineering, Rotary Driers, Chapter II, Section 11.11, pp. 292-295.

to help solve these problems, four plants were selected for detailed study.

Earl Anderson[2] quotes W. C. Fairbanks, agricultural engineer, University of California, saying that the failure of dehydrating plants is due to mechanical and marketing problems. The mechanical problems include high initial investment, high energy requirements, and severe corrosion of dryer parts. The marketing problems are due to lack of established markets at the premium price necessary for dehydrated manure to be profitable. Also important are odors resulting when ineffective after-burners fail to eliminate escaping particles.

Dehydrator Design

The four plants covered in this study used converted alfalfa dehydrators as rotary dryers. The drums of these dryers varied from 30 to 40 feet in length and from 4 to 10 feet in diameter, and were set horizontally. They were supported by four bearing and trunnion assemblies, two of these being located at each end of the drum. A metal tire or rim at each end of the drum made contact with the bearings and provided the bearing surface on which the drum rotated. An electric motor and gear assembly provided the power to rotate the drums.

Henderson and Perry, in describing rotary dryers, state that the rate of material moving through the drum is controlled by one or more factors — flight design, incline of the drum, and rate of heated air through the drum. The capacity in pounds of material per hour depends upon the required reduction in moisture content, the drying indices for the material, the rate of air flow, and the size of the drum.

All of the rotary drums in this study contained internal flighting, which was an integral part of the outer wall of the drum. This flighting was either welded or bolted to the outer wall, and it tumbled the material being dried across the inside of the drum and through the fire and heat from the furnace. All of the dryers were direct fired.

The heat for drying was supplied by natural gas which was burned either in one large nozzle or from several small nozzles. One dryer utilized five nozzles. Some of the dehydrators were located in areas where their operation was limited to periods when gas was available in adequate quantities. Their operation was restricted during periods of low atmospheric temperatures when residential consumption of gas was high.

All of the dehydrators studied had a relatively large electrical power demand. The electrical motors used were 3-phase, 200-400 volts. The connected electrical load was generally over 200 hp. The following list shows some of the motor sizes which were used:

	Horsepower range
Rotary drum	10 - 50
Shredder	10 - 20
Chain conveyor (raw material)	3
Feeder	5 - 7½
Drum fan	20 - 50
Stack fan	40
Hammer mill	40 - 100
Air compressor	1½ - 3
Augers	1½ - 15
Elevators	1½ - 3
Sacker	1

Dehydrator Operation

Description of operations

Materials processed through dehydrators consisted of cattle manure and bedding. The bedding was straw or a low quality prairie hay. This waste was cleaned from cattle pens and alleyways on a fairly regular schedule, and trucked to a storage site located near the dehydrating plant. After the waste was unloaded, it was piled by means of a small crane or dragline generally mounted on a truck chassis. The piles (fig. 1) were allowed to go through a "sweat" period and were turned at least once before being processed.

As the material went through the "sweat" period it lost some moisture. As a result, the moisture content of the material going into the dehydrator was somewhat less than when the material was first stockpiled. In some cases, there was a drainage or seepage from the stockpiles. There have been complaints about this, and in some states and localities, pollution regulations prohibit this drainage or seepage from entering natural waterways.

The material was moved from the stockpile to

[2] Anderson, Earl. Turning Waste into Profits, Farm Quarterly, Nov.-Dec. 1970, Vol. 25, No. 6, pp. 45-47, 85.

Figure 1. — Typical manure dehydrating plant.

the dehydrator on a conveyor. In this study, material taken from the conveyor just before it entered the rotary drum was analyzed for moisture. The moisture content ranged from 38.7 to 64.5 percent.

Extremely important is the moisture content of the dried material leaving the rotary drum, and it is difficult to control. Moisture content is affected by the temperature of the air leaving the drum and the volume of raw material entering the drum.

Depending upon the material being dried, an exhaust air temperature of approximately 300° F was maintained. The volume of material entering the rotary drum was controlled to some extent by the amount of fuel used. There was, however, a definite limitation on the degree of control accomplished by regulating fuel flow.

When the raw material being processed had a moisture content under 45 percent, the amount of fuel used decreased or the volume of material processed increased. At this moisture level, care was exercised in controlling the air temperature or the material would catch fire and burn in the rotary drum. Such a fire is hard to extinguish and results in an acrid smoke.

Raw material with a moisture content above 60 percent results in the emission of considerable steam from the exhaust stack. Material with moisture contents above this level is also harder to dry. There is a tendency for high-moisture material to form balls in the dryer. These balls become surface-hardened, and are extremely difficult to dry and remove from the drums. It is for this reason that fresh manure cannot be dried in a rotary dryer.

One of the dehydrating plants studied was designed to allow for the recirculation of part of the dried material. The design arrangement allowed the dried material to fall on top of the wet material on the feed conveyor just prior to entering the rotary drum. This did not prove workable

because there was no way to mix the wet and dry material. In addition, more time than was available was required for the equalization of moisture between the dry and wet material. This design feature resulted in burning the dry material when it entered the rotary drum.

Several dehydrating plants mix wood chips with fresh manure to absorb some of the moistture. This mixture is then fed into the rotary driers. The wood shavings not only absorb moisture from the fresh manure but also prevent the formation of balls of material in the rotary drums. After the mixture has passed through the rotary drum, it is screened to separate the wood chips from the dried manure. The wood chips are then reused.

The flow pattern for cattle manure through a dehydrating plant is shown in figure 2. The major components and processing areas of the plant are designated.

A labor crew of from four to six men was required to operate the dehydrator. The operation started with stockpiled raw material and ended with the dried product placed into storage. The crew was utilized as follows: One man operated the loader moving raw material from storage piles to raw material hopper; one man operated the belt feed and dryer controls; one to three men operated the bagger, sewed bags, and placed filled bags on storage pallets; and one man operated a forklift truck which moved loaded pallets to temporary storage and from there to the storage warehouse. The man moving the loaded pallets also assisted around the plant as needed.

The only place that labor can be reduced is at the bagger. With some types of bags, it is possible

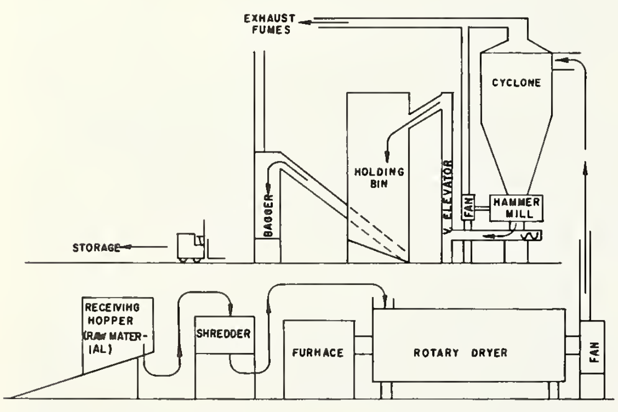

Figure 2. — Flow pattern of cattle manure through a dehydrating plant.

to operate this unit with one man. He is able to fill the bags, seal them, and place them on the storage pallet.

When the empty bags are completely open at one end, at least two men are required to fill the bag, sew the end of the bag, and place the bag on the storage pallet.

The loaded pallets are moved to a temporary storage, isolated from the normal storage area by fire doors. After 4 or 5 days, this material is moved to the regular storage area. This policy has been adopted after some disastrous fires occurred. These fires were caused by bagging dried material which contained hot particles, or spontaneous combustion which occurred when wet material was bagged with dry material. Large amounts of water were required to extinguish such fires. When the bags become wet, they often burst, spilling the material. Material from a fire can be recycled through the dryer.

Operating problems

Several problems must be considered in operating a dehydrating plant. A major problem which has already been mentioned is the possibility of a fire in the storage area. When bagged, the dried material may not be completely cool. In addition, small particles may have become ignited as they passed through the rotary drum. These particles may continue to glow or burn after they pass through the hammer mill, and there is constant danger that some of these will be bagged. The danger of spontaneous combustion exists when a small amount of wet material is bagged with dry material, and this occurs occasionally.

The nature of the product, which becomes abrasive when dry, is a problem. This abrasion results in holes in duct work, elevator and auger housings, and any place where the dry product comes into contact with light-gage metal.

Once in the air outside the dehydrator, this dry material will get into bearings, motors, and on other metal surfaces. This results in a short life for bearings and other items which are expensive to replace.

Another problem occurs when the dried material gets into the air, creating a dusty environment. Employees at dehydrator plants complain about this dust and the dirty surfaces which result. Once the material is in the air, everything

around and inside the dehydrating plant is soon covered with this dust.

An odor problem is associated with this dust. Odor is very apparent when a great deal of airborne dust is present in and around the plant. Control of dust and odor is important if plants are to remain in operation. Not only are these two items health hazards, but they can be a public nuisance.

Operating costs

The operating costs of a dehydrating plant consist of labor, fuel, electricity, repairs, and miscellaneous costs.

Fuel costs ranged from 0.085 cents to 0.200 cents per pound of dried product, in dehydrating plants producing from 750 to 4,000 pounds of dried product per hour.

Electrical power costs ranged from 0.075 to 0.200 cents per pound of dried product.

Repair costs were probably high for these dehydrating plants because of the age of the plants. The nature of the material being dried also affects the amount of repairs needed. The cost for repairs was from 0.3 to 0.4 cents per pound of dried product.

Labor was the largest cost item in the operation of these dehydrating plants. It accounted for 60 to 65 percent of the total operating cost, ranging from 1.1 to 1.3 cents per pound of dried product.

Miscellaneous costs ranged from 0.05 to 0.09 cents per pound of product.

The total operating cost for producing a pound of dried product ranged from 1.6 to 2.2 cents.

Boyd, Surgrook, and Zindale[3] reported total costs of 3.44 cents per pound of dried product in operating a small dryer processing bovine manure and 2-percent straw at a processing rate of 340 pounds of dry product per hour. This study showed a fixed cost of 1.050 cents and an operating cost of 2.393 cents. The operating costs per pound of finished product for the small dryer were as follows: Labor, 0.735 cents; electricity, 0.205 cents; and fuel, 1.453 cents.

Merchandising Dehydrated Product

Dehydrating plants sell the dried product as a specialty fertilizer. It is packaged in 5-, 10- 25-, 40-, or 50-pound bags made of paper or plastic. Generally, these are sold to a retailer who has several outlets. These retailers are hardware stores, nurseries, or lawn and garden supply stores.

One of the problems in packaging or bagging dried manure for use as a specialty fertilizer is the control of the bulk density of the material. The heavier the material, the less volume it occupies in relation to its weight. This gives a sack the appearance of being only partially filled even though it contains the stated weight. The drawback to this is that the product loses its eye appeal to a potential customer, making it more difficult to merchandise.

The bulk density is influenced by the amount of dirt, sand, or excess bedding that is processeed, dried, and bagged. Sand or dirt not only increases the bulk density, but also is detrimental to machinery and results in a shorter machinery life.

The Association of American Plant Food Control Officials[4] has proposed some definitions related to dried manures. Some States have adopted these definitions as part of their State fertilizer regulations. For example, manures from stockyards and dairy barns can be dried and labeled as "Dried Cattle Manure from Stockyards, etc." Manures containing more than 30-percent acid insoluble ash (sand) shall be labeled "Dried Cattle Manure and Sand." Manures containing more than 50-percent acid insoluble ash (sand) shall be labeled "Dried Sand and Cattle Manure."

This regulation makes any dried product containing more than 30-percent sand harder to sell. Buyers may be reluctant to purchase a product labeled "Dried Cattle Manure and Sand" and probably would be more reluctant to purchase one labeled "Dried Sand and Cattle Manure."

Some states require registration of brand names and analyses. These brand names are descriptive and reflect the product or company processing it. Some of the typical names are "Blue Ox'n," "Longhorn," "Ramshorn," "Yard'O," and "Cow'O."

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[3] Boyd, J. S., Surgrook, T. C., and Zindale, H. C., Drying Animal Waste. Information Sheet No. 250, Agr. Engin. Dept., Coop. Ext. Ser., Michigan State University.

[4] Publication No. 23. Official Publication of the Association of American Plant Food Control Officials 1969-70.

Analyses for dehydrated manures, as registered where required, are guaranteed. The analyses apply to the three major fertilizer elements — nitrogen, phosphorus, and potassium. Dehydrated manures range from 0.5 - 0.5 - 0.5 - to 2 - 1 - 2. The material is frequently inspected and analyzed, and if it does not meet the analysis as registered the manufacturer or distributor is subject to a penalty or fine.

The inspection and analysis of dehydrated manures offered for sale also covers the amount of sand or inert matter in the dried product. This is done to see that the product is properly labeled.

Conclusions

Dehydration is a usable method of disposing of large quantities of cattle manure and bedding on livestock markets.

Problems associated with the operation of a dehydrating plant are the possibility of fire in storage areas, the difficulty of drying raw product with a high moisture content, the possible damage to the dehydrating equipment caused by the abrasive nature of the dried product, the effects of dust from the dried material on the equipment and to the plant workers, and the odor which is generally present at a manure dehydrating plant.

The dehydrated product can be merchandised as a low-analysis fertilizer. Revenue from sales may cover costs of operating the plant and little or no profit should be expected. Dehydration should be considered primarily as a method of disposing of large quantities of waste material on livestock markets. As revenues generally cover operating costs, dehydration may be the lowest-cost method of disposing of waste on livestock markets when compared to conventional loading, transporting, and spreading on land.

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